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THE COLUMBIA RIVER BASIN PROJECT FOR WATER SUPPLY AND WATER QUALITY MANAGEMENT

Public Health Service
Portland, Oregon

March 1961

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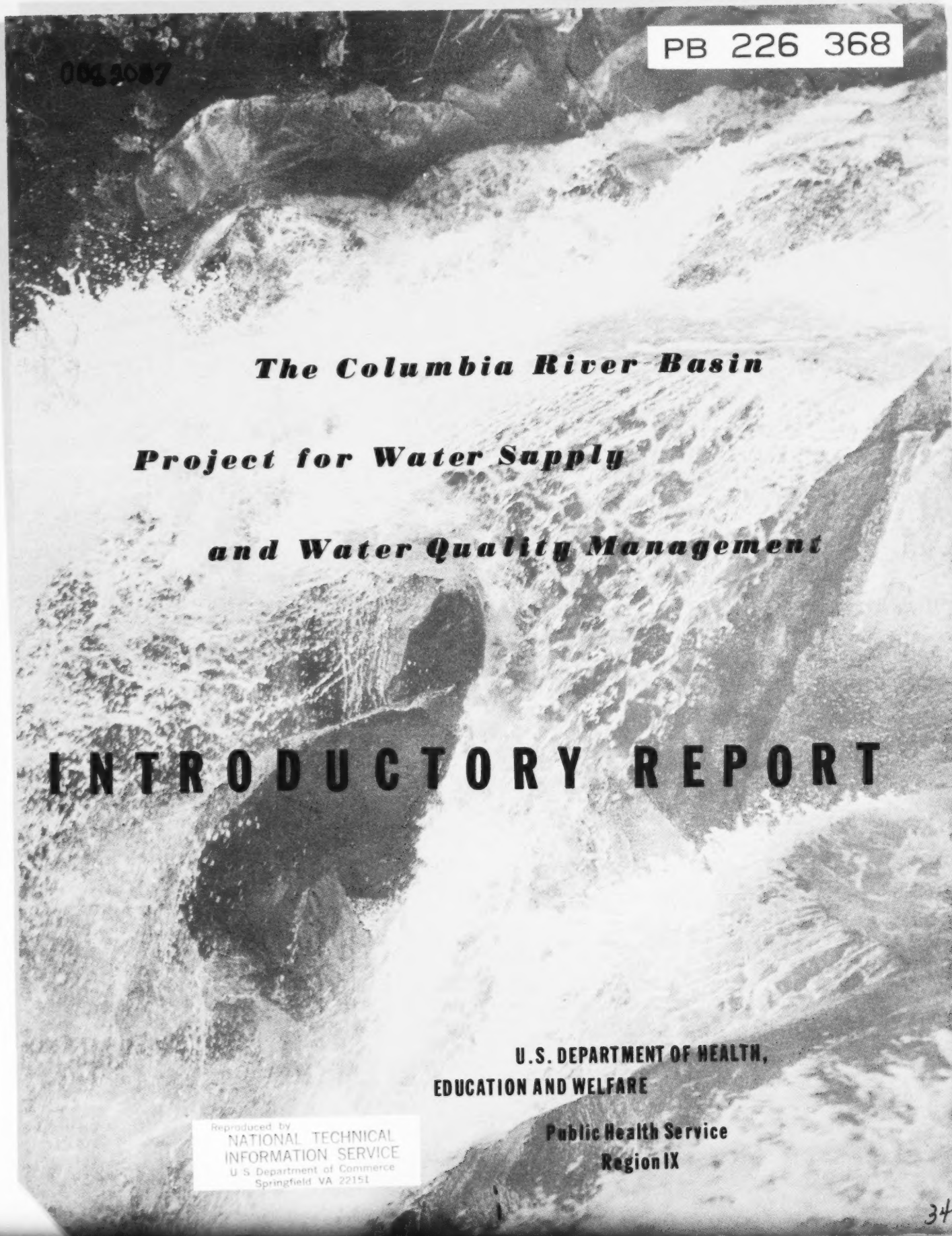

The Columbia River Basin

Project for Water Supply

and Water Quality Management

INTRODUCTORY REPORT

U.S. DEPARTMENT OF HEALTH,
EDUCATION AND WELFARE

Public Health Service
Region IX

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FORESTS,

CLEAN WATERS

and SCENIC

BEAUTY

CHARACTERIZE

the PACIFIC

NORTHWEST

The Columbia River Basin
Project for Water Supply
and Water Quality Management

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COLOR ILLUSTRATIONS REPRODUCED
IN BLACK AND WHITE

The development of comprehensive water resource plans by river basins, coordinated among all concerned agencies and levels of government, and providing maximum benefits for all purposes--hydroelectric power, irrigation and reclamation, navigation, recreation, health, home and industry--are basic national goals stated by the President in his Natural Resources Message of February 23, 1961. "The full development of the power and other water resource potentials of the Columbia Basin is a vision that must be fulfilled," is a specific goal addressed to the Pacific Northwest.

This Introductory Report describes and explains the contribution that the Public Health Service is making to the development of the water resource potential of the Columbia Basin. Water supplies for cities and industries, pollution control and water quality management, and water pollution research are lagging aspects of the Columbia Basin development program. The importance of these aspects to public health and economic well-being, today and in the future, is widely recognized. The Columbia River Basin Project will complement the planning, construction and operation programs of the other Federal Departments, the States and private industry, and will close an important gap in planning for the full development of the water resources of the Columbia Basin and the Pacific Northwest.

Leonard B. Dworsky

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Officer-in-Charge
Water Supply and Pollution
Control Program
Pacific Northwest

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INTRODUCTION

The United States Public Health Service, Department of Health, Education and Welfare, is undertaking the preparation of a comprehensive water supply and water quality management plan for the Columbia River Basin and adjacent coastal areas as a portion of the overall water resource development program of the Pacific Northwest. This introductory report describes the project which has been designed and initiated to gather the necessary information and data and to formulate this plan.

SCOPE AND PURPOSE OF PROJECT

The Columbia River Basin Project deals with water supply requirements for domestic, municipal and industrial purposes, and with the management of the quality of the region's water resources as this affects public health; municipal growth and industrial development; fish, shellfish, and wildlife resources; agricultural water supplies; and recreation.

The project is one of a series of similar regional projects 1/ designed to plan for the improved development and utilization of water resources to meet the requirements of future years, and to alleviate pressing current problems.

Authority for the project stems from the Federal Water Pollution Control Act (P.L. 660, 84th Congress) and the Public Health Service Act (P.L. 410, 78th Congress). In accordance with this authority, the project will be carried out in cooperation with other Federal agencies, with State and interstate agencies, with municipalities and industries, and with other organizations concerned with water and related land resources development in the Pacific Northwest.

The project findings will complement the water resource development reports of the Corps of Engineers, Department of the Army, for flood control, navigation, hydroelectric power, and related water uses; of the Bureau of Reclamation, Department of the Interior; for irrigation and related multipurpose developments; of the Department of Agriculture for development of small watersheds; and other Federal agencies having responsibilities for water resource development. The project will involve correlative studies with such agencies as the U. S. Fish and Wildlife Service (to consider quality and related low flow requirements for fish and wildlife conservation), the U. S. Forest Service and the National Park Service (to consider the effect of pollution, sediment control and flow regulation on recreational opportunities) and the U. S. Geological Survey (to obtain data on both quality and quantity aspects of surface and ground water supplies).

1/ These include the following current project areas: Arkansas-White-Red River Basins, Colorado River Basin, Great Lakes.

The project will supplement, rather than replace or make less necessary, State and local planning operations in both water supply and water quality management activities. It will provide a framework to guide the development of municipal and industrial water supplies and waste disposal facilities in specific situations. It will make available basic information on opportunities for coordinated developments that can offer important economies as a result of joint or sub-regional action.

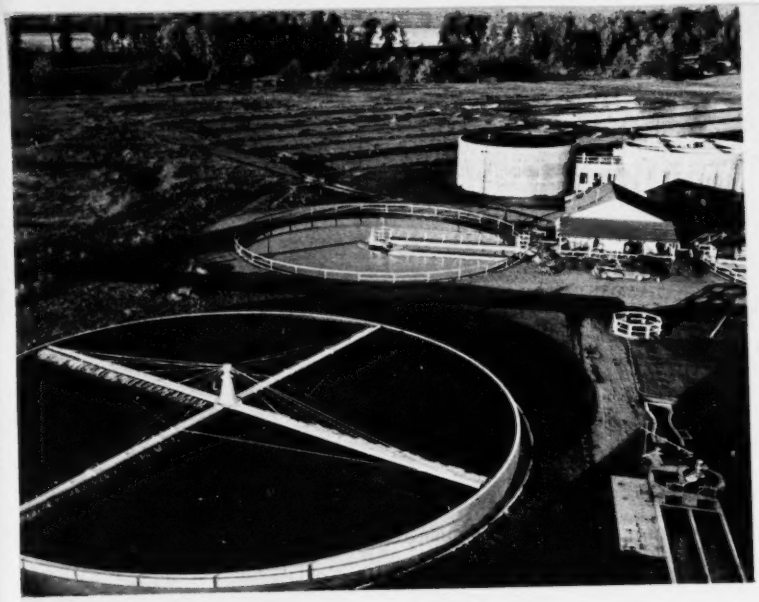
The planning area of the Columbia River Basin Project is defined to consist of the United States portion of the Columbia River Basin and the adjacent Puget Sound Basin, Oregon and Washington coastal areas, and southern Oregon lakes area. The comprehensive plan will be designed to meet water requirements of the Pacific Northwest over the next half century, with the planning period ending in the year 2010. Forecasts will also be made for a midperiod of 1980.

BASIC CONCEPTS

Water supply and water quality management are inseparable parts of water resource development. In order to meet the water supply and water quality management requirements of the region, it is necessary to consider the availability and adequacy of water resources, in terms of both quantity and quality factors, throughout the full length of the region's streams. Essentially, the water supply requirements of future years must be met by storing and conserving water during periods of excess flow for later release, and by reclaiming used water through restoring its quality in order that it can be used repeatedly as it flows through the water courses of the Columbia Basin.

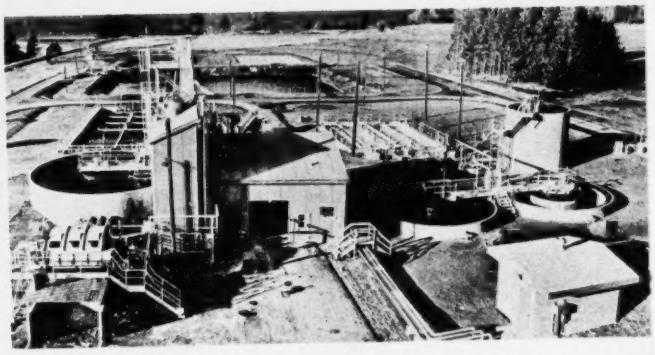
The protection and restoration of water quality involves two major facets: control of polluting wastes and flow augmentation during periods of low streamflow. From the standpoint of cities and industries, water intake and output should be regarded as a complete cycle. This cycle involves withdrawing water from the river, treating and utilizing it, and then treating it again to remove wastes before discharge. In this way, the same water can be reused to serve multiple needs. The regulation of streamflow during low flow periods supplements, but is not a substitute for, waste treatment in water quality control. Such regulation provides wide benefits by aiding in the reclamation of used water for further reuse, just as the regulation of streams to control flood flows provides benefits in preventing flood damage.

Streamflow regulation for the purposes of meeting both quantity and quality needs is usually possible as a phase of multipurpose development for such other uses as flood control, irrigation, or power. The regulation of low streamflows, therefore, will be an important element of the study. The report will integrate the demands of its primary interests with the river control plans of Federal and other agencies, and should enable provision for water supply and



Sewage treatment plant, Eugene, Oregon

Treatment works such as these protect the quality of the region's waters.



Oil refinery waste treatment plant, Ferndale, Washington

water quality control needs as components of multipurpose projects. Future growth and development of the region's communities and industries will increase the competition for storage capacity and stored water, already critical in some places. Advance planning should enable competing demands of population, agriculture, industry, and fisheries to be met with a minimum of conflict.

The difficulty of maintaining or restoring water quality is continually increasing, because of the growing quantity and variety of pollutants affecting streams. Population and industrial growth are resulting in increased quantities of sewage and industrial wastes. In addition, new technological developments are contributing new kinds of wastes, and this will continue to have an impact on the quality of the region's water resources. Although many situations can be met with existing knowledge, new findings will be required to deal with new problems, such as those arising from the growing use of complex chemicals in industry and agriculture.

A major regional need, to be undertaken in this study, is a clear and early evaluation of research requirements: that is, the new knowledge that must be developed to keep abreast of pollution and maintain water of suitable quality for various uses. The varied geographic situations in the Pacific Northwest, encompassing the coastal maritime climate, the arid western climate, and highly fertile valleys with their water reservoirs in snow-capped peaks, present special problems which can be best studied within the region itself, at both existing and new research facilities.

Through continuing Congressional action, large amounts of Federal funds are being spent in the region and in the Nation to stimulate the construction of municipal sewage disposal facilities. This program was begun in 1956. As of December 1960, Congress had granted funds totalling $208,000,000 to communities throughout the Nation. These grants have matched $1,009,000,000 in local funds involved in the costs of these projects. For the Pacific Northwest, Federal construction funds have totalled approximately $10,000,000, matching approximately $32,000,000 of local contributions.

The program of Federal construction grants was planned to meet pollution control requirements visualized in surveys made during the past decade. The proposed report will provide a basis for relating these appropriations to current and foreseeable future problems on an up-to-date basis for the Pacific Northwest. This improvement in the planning phase will also provide a guide to the most effective and balanced expenditure of Federal, State and local appropriations to bring about a more rapid clean-up of the various basins.

ELEMENTS OF THE PROJECT

The findings of the project will directly aid the programs of agencies responsible for conserving and developing the water resources of the Pacific Northwest to meet the region's growing needs. The project's four major sections, and ways in which the findings can be utilized, are as follows:

1. The determination of the water requirements for municipalities and industries in the Columbia Basin region and the development of engineering recommendations to meet these quantity requirements. These findings will be used in conjunction with the development of plans by the Federal construction agencies, to guide them in making provision in multipurpose reservoirs for meeting water supply needs. They will also provide a broad framework of regional and sub-regional water supply potential to guide cities and industries in the development of their own specific needs.

2. The development of a water management plan to protect and control the quality of the region's water resources including: (a) determination of requirements for treatment or control of pollutants produced by municipalities and industries, (b) identification of agricultural, forest, range and other land-use practices which adversely affect water quality, and remedial measures to reduce or control such effects, (c) determination of needs for the regulation of stream flows, particularly for the augmentation of low flows to safeguard and enhance water quality. These findings will be used by the States in establishing priorities for the expenditure of Federal funds to stimulate the construction of municipal sewage treatment works. They will, in conjunction with the findings on water supply requirements, guide the development of the plans by the Federal construction agencies, to include provision in multipurpose reservoirs for meeting water quality management needs. They will guide pollution control enforcement programs by establishing basic facts and more clearly defining pollution problems. This will aid in the development of strengthened State enforcement programs, and, where interstate problems requiring Federal action are defined, will provide a factual basis for Federal regulatory activities.

3. The development of a report on the adequacy of water resources to meet the needs of the major water using groups, making available information on the volume and the physical, chemical and biological quality of the region's water resources. The report will assemble and interpret data giving the present status of the adequacy of the water supply with special reference to water quality, and will serve as a basis against which changing trends may be judged. It will provide concise and usable information for present and potential water users planning for future utilization of the region's water resources.

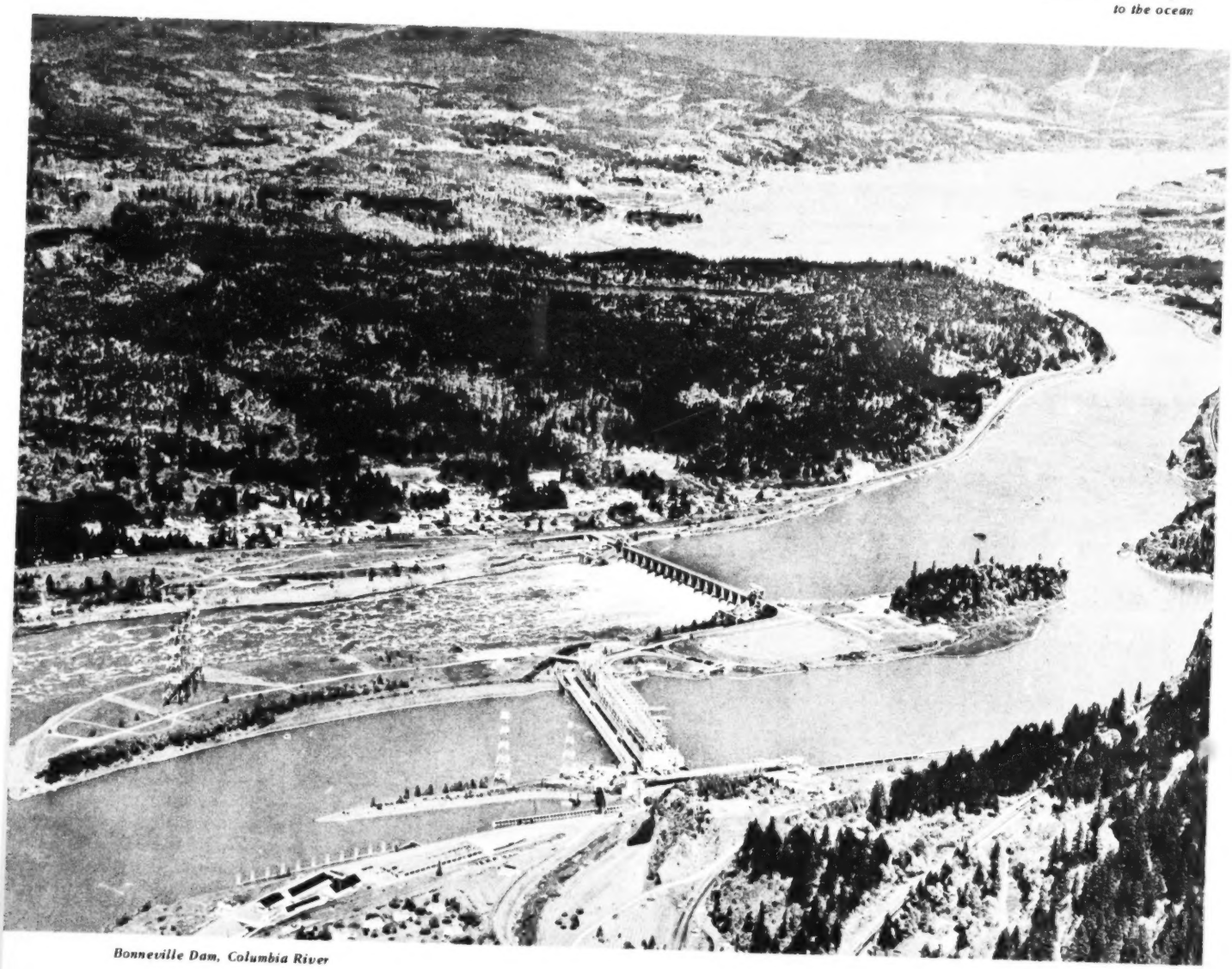
4. The identification of research needs, with particular emphasis on the problems unique to the Pacific Northwest region, and the recommendation of measures for implementing such research at appropriate public and private facilities. These findings will aid in the solution of technical problems where adequate knowledge is now lacking, by calling the attention of investigators to the most pertinent and useful areas of research. They will provide a guide to the selection of appropriate research projects to be undertaken by the Public Health Service, or to be supported at other public and private institutions through contracts or research grants.

Increasing amounts of reservoir storage will be needed to provide for municipal and industrial water supply requirements and to complement waste treatment by regulating streamflows.

Detroit Dam, North Santiam River, Oregon

The findings of the project will enable water supply and water quality management needs to receive the attention that they merit in the planning, programming, and operation of comprehensive programs for the development of the region's water resources. They will guide the Public Health Service and the States in carrying out their continuing responsibilities for these functions in the Pacific Northwest.

The Columbia River passes through the Cascade Range, providing a water route from the Inland Empire to the ocean



Bonneville Dam, Columbia River

THE PACIFIC NORTHWEST REGION

The nature of water problems and water requirements in the Pacific Northwest is governed by the physical and economic characteristics of the region. The following discussions briefly describe these characteristics as background to an understanding of the region's water supply and water quality management needs.

PHYSICAL CHARACTERISTICS

The Columbia River Basin is the predominant physical feature of the study area, comprising over eighty per cent of the Pacific Northwest region. The Basin can be divided into three main parts:

The Basin's great southern flank centers on the Snake River, with its vast plain encompassing all of southern Idaho. The western tributaries of the Snake stretch deep into eastern Oregon. Flowing through Hells Canyon, the Snake meets the Columbia at its great southern bend in eastern Washington. With one arm rising in Yellowstone Park and flowing east of the Grand Teton Mountains, and with the other arm, Henry's Fork, draining the west slope of the Tetons and the south rim of the Continental Divide, the Snake drains about forty-two per cent of the total Basin and comprises about twenty per cent of the total stream runoff of the Columbia Basin.

The northeast quadrant is set off from the Snake Basin by the rugged mountain ranges of central Idaho. This part contains the important northern tributaries: the Kootenai, the Clark Fork, and the Pend Oreille.

The third part, the main stem of the Columbia, rising in the ice fields on the western slope of the Canadian Rockies, produces half of the Basin's water supply. Flowing south, centrally through the State of Washington, the Columbia meets the Snake and, turning west, flows 300 miles to the ocean. The estimated natural flow at the mouth of the Columbia River is nearly 180,000,000 acre-feet annually.

The eastern and western portions of the region stand in rugged relief against a large central upland plateau. The Columbia Plateau, 100,000 square miles of semi-arid and nearly treeless land, was formed from repeated lava deposits. The Rockies on its east include some of the most scenic and spectacular views to be seen anywhere on the North American continent. They range from Yellowstone and Grand Teton National Parks on the south, through Glacier National Park and the Waterton Lakes boundary areas, and north to the Canadian ice fields. To the west of the Columbia Plateau lie the Cascade ranges, with their high, snow-capped, glacier-laden peaks which can be viewed for a hundred miles. West of the Cascades, lying in succession, are the Willamette-Puget Trough, the Coast Range stretching from the Olympics on the north through Oregon, and the narrow coastal shelf with its varied scenes of wide beaches and rugged coastline, and its steelhead and salmon spawning coastal streams.

The important land areas which support the more intensive farm and range lands and major concentrations of population in the Pacific Northwest are the Willamette-Puget lowland, the Yakima Valley, the Columbia Plateau, and the Snake River Plain. Small but important valleys such as the Bitterroot, Flathead, and Okanogan are scattered all through the highlands.

Almost half the land area in the United States portion of the region is in forests. This represents the last major timber reserve outside of Alaska and contains most of the Nation's first class timber supply. About one quarter is open range land; another quarter is used for crop and other agricultural land; less than five per cent represents municipal, railroad, highway, and other miscellaneous uses.

The climate of the Pacific Northwest is primarily continental, with the exception of the hundred-mile strip west of the Cascades, which is relatively warm and humid as a result of the maritime influence. In less than fifty miles the wet maritime climate shifts sharply to desert in the rain shadow of the Cascades. For most of this area east of the Cascades, precipitation falls primarily as snow. Precipitation in the interior lowlands approximates ten inches annually. Two large elevated plateaus, the Snake River Plain and the Columbia Plateau, experience from ten to twenty inches of precipitation. In the interior mountains, precipitation ranges from twenty to sixty inches. These well-watered mountainous areas are strategically placed throughout the region, and the forest cover helps to even streamflow fluctuations throughout most of the year. The Columbia River draws upon the most extensive glacial ice fields in North America outside of Alaska. This gives high stability to the northern drainage of the Columbia system.

A major hydrologic difference between interior basins and coastal basins lies in the seasonal variation of annual runoff. A typical interior stream's runoff will be about twelve per cent from October through March, in contrast to sixty-five per cent for the same period for a coastal stream; with eighty-eight per cent of the annual runoff moving through the interior basin from April through September, as against thirty-five per cent during this period in the coastal basin. The contribution of snow melt to average annual runoff is much greater in interior streams than in coastal streams.

ECONOMIC CHARACTERISTICS

The economy of the Pacific Northwest has been largely influenced by the development of natural resources. The most important single category of economic development has been the harvesting of products grown on the land. These products include those from forestry and those from agriculture. Other important economic resources of the Pacific Northwest include electric power, minerals, scenic grandeur, and a strategic location. Water for irrigation, falling water for power, and water for transportation have been of particular historical importance.

Forests and agricultural lands are dominant in the region's economy.

Water, too, plays a dominant role – for irrigation, for hydroelectric power, for fish and shellfish.

Population

With a population of almost 5,500,000 in 1960, the Pacific Northwest had about three per cent of the total United States population. The area's population growth since 1950 has been less than the Nation's growth. The annual growth rate during the last decade has been 1.6 per cent, as compared with the national growth rate of 1.8 per cent. It has been predicted, however, that over the next 25 years the Pacific Northwest population is anticipated to be at least comparable to the national growth rate.

The distribution of population among the Pacific Northwest states is as follows:

	(Per cent)
Washington	51.6
Oregon	32.3
Idaho	12.1
Western Montana	4.0
Total Pacific Northwest	100.0

Two thirds of the region's population live in the area west of the Cascade Mountains, which constitutes less than a fourth of the total land area of the region.

Manufacturing

Manufacturing is the largest single category of employment in the Pacific Northwest. Within this category, lumber manufacturing is the major activity. Transportation equipment is the second largest activity, largely as a result of the Boeing airplane manufacturing operations. The third largest category is the manufacture of food products.

Primary metals manufacturing provides substantial employment, employing about three times as many people as mining. This employment is largely associated with aluminum reduction facilities which were attracted to the area because of the availability of low-cost hydroelectricity, but which import most of their raw materials.

Mining

The Pacific Northwest had about two per cent of the Nation's mineral production in 1958. Although the bulk of the value of this production was for sand, gravel, and other materials used by the construction industry, the area also produced significant quantities of nickel, silver, lead, zinc, copper, gold, coal and phosphate rock. The largest concentrations of metal deposits are in the Coeur d'Alene, Idaho and Butte, Montana districts. With a few exceptions most other mineral deposits now being worked can be classed as industrial minerals, rather than metals.

Electric Power

The Pacific Northwest contains about thirty-five per cent of the Nation's potential hydroelectric resources, but only about one fifth of these resources have been developed. The majority of the area's power production comes from the Federal developments comprising the United States Columbia River Power System, and almost all of the region's power generation is from hydroelectric sources.

On a per capita basis, the region's electricity consumption in 1958 was 2.4 times as great as the Nation's. Although domestic consumption is greater than the national average, the large quantities of power used by heavy industry are mainly responsible for the high per capita consumption. The Bonneville Power Administration at mid-1959 was serving directly eighteen industries, most of which could be termed electroprocess industries. Eight of these were aluminum plants. The average cost for BPA power delivered to both industries and utilities was 2.33 mills per kilowatt-hour in 1959.

Forestry

The forests of the Pacific Northwest contain half of the Nation's total saw timber volume. At the present time they supply over a third of the Nation's annual cut of saw timber. Beginning from a historical concentration on saw timber and lumber production, the region has greatly diversified the uses of its timber resource. Recent estimates are that the Pacific Northwest contributes eighty-five per cent of the national softwood-plywood production, seventeen per cent of the pulp and ninety-five per cent of the wooden shingles and shakes. Other products include treated timbers, composition boards, and chemicals extracted from wood and bark. With the growth of western population there has also been a growth in local manufacturing of forest products for western consumers. This manufacturing includes furniture, boats, and containers.

Agriculture

Agriculture is a leading industry in the Pacific Northwest. Varied types of agriculture are practiced in the region. Among these are dairying in the coastal areas, fruit in sheltered valleys on the east slope of the Cascades and in the Willamette Valley, wheat in eastern Washington and northeastern Oregon, potatoes and sugar beets along the Snake River, and cattle on upland ranges east of the Cascades. Wheat is one of the area's major crops, with about three fourths of the annual production being exported. The area exports dairy and poultry products, but despite its large cattle and livestock industry, has a net import of meat products.

Irrigation is required for most crops, other than wheat, in all areas east of the Cascade Mountains. It is becoming increasingly important in some inland areas west of the Cascades, such as the Willamette Valley where, although the annual precipitation is high, the summertime

precipitation approaches that of the arid eastern part of the region.

Fish and Wildlife

The fisheries and wildlife resources of the Pacific Northwest are valuable for both recreational and commercial purposes. From the sport fishing and hunting standpoint, the region is regarded as one of the bes' areas in the Nation. Expenditures totaling millions of dollars are made by both residents and tourists in pursuing these sports. Commercial fishing for salmon and shellfish is an important industry in the coastal areas of the region.

Outdoor Recreation

The scenic resources of the Pacific Northwest are outstanding. The varied recreational opportunities afforded by lakes, mountains, rivers, and seacoast are considered to be one of the principal amenities of the region. In addition to providing recreation for the region's residents, these resources have great economic value. They attract a substantial tourist industry, estimated to represent from five to ten per cent of income flowing into the region.

Strategic Location

Bounded on the west by the Pacific Ocean, the region has direct water access by ocean vessels to world ports, particularly to those of the Pacific Basin. The region is the United States terminus of all "great circle" routes to the Orient. Water-borne commerce to both California and Alaska is also served from the area. The usefulness of the Northwest as a shipping terminus is considerably enhanced by the Columbia River which provides both a land and a water corridor through the Cascade Range.

Water-borne commerce to and from Pacific Northwest ports in 1956 amounted to 28,500,000 tons. About 12,500,000 tons of this was to ports on the Columbia River. Only one third of this tonnage was in foreign trade.

Recreation is a major regional asset, contributing both to the economy and to healthful living.

The region's water supplies are not evenly distributed. Abundant water flows from its sources in the mountains to the ocean through arid lands.

WATER SUPPLY AND WATER QUALITY MANAGEMENT: PROBLEMS AND PROGRAMS

Water resources are of vital importance to the growth and development of the Pacific Northwest. Power production, fisheries, irrigation, flood control, recreation, and navigation have all been key public issues within the region. The effects of hydroelectric development upon anadromous fisheries, the extension of navigation facilities, the provision of adequate flood control storage with consequent inundation of agricultural lands upstream, and the operation of storage reservoirs to provide maximum recreational opportunities are examples of the wide range of water resource issues of major significance.

Water supply and water quality management are of commensurate importance to the region, and in many cases are directly related to the aspects of water resource development cited above. Although the Pacific Northwest has a lower population density than the United States average and its degree of industrialization is considerably less than the national average, it has both immediate and long-range water supply and water pollution problems. Many of these problems are of a special regional nature because they stem from conditions and require solutions that are peculiar to the Pacific Northwest.

The following discussions will briefly describe these regional problems as they relate to each of the four facets of the proposed study: water supply, water quality management, utilization of water, and research requirements.

Water Supply

The Pacific Northwest, as a region, has abundant water resources, with an estimated average annual yield totalling over 300,000,000 acre feet. This is well in excess of the annual withdrawals, which were estimated in a recent report of the United States Senate Select Committee on National Water Resources to be as follows (in acre feet):

	Municipal	Manufacturing	Total Withdrawal Uses
1954	853,000	1,300,000	27,700,000
1980	1,570,000	9,450,000	39,100,000
2000	2,540,000	21,600,000	85,200,000

Despite the water surplus indicated by these figures for the region as a whole, water is already in short supply in some parts of the region, and water demands will continue to grow more pressing. The water supply of the Pacific Northwest is unbalanced in geographic distribution, as well as seasonally. The regions of high precipitation are limited to the areas west of the Cascades and to relatively isolated areas of high mountainous country in the interior. Between these latter sources and the sea, the rivers flow through vast areas of arid land. A high proportion of the region's total runoff is confined to the relatively narrow valleys of the Columbia River and its major tributaries. The economy of the intervening arid areas is largely dependent upon distributing water from these widely separated major streams to adjacent lands for irrigation. These withdrawals are great, and in some sub-basins they already result in extreme depletion of flows. Even in some parts of the wet area west of the Cascades, water shortages occur or are anticipated, as a result of intensive municipal, industrial, and agricultural development. Thus, large parts of the Pacific Northwest are areas of water scarcity, despite the vast, relatively untapped supplies existing elsewhere in the region.

The region's water shortages are mainly seasonal ones, occurring during periods of low streamflow. It is characteristic of the region that these low flows are of long duration. Much of the annual runoff occurs as a result of massive snow melt, and is followed by long dry periods. Programs to provide for present and future water supply needs in water-scarce areas will involve the storage of water for use during dry periods. This can be accomplished by making provision for the storage of surplus flows during wet seasons in multipurpose reservoir projects and in some cases in ground water aquifers, specifically for municipal and industrial water supply purposes. Watershed management to reduce seasonal low flows affords another potential management device in some areas.

Mounting demands on water resources require that domestic and industrial water supply needs be integrated into basin-wide water management programs, and provision for water supply needs will be increasingly included in Federal multipurpose projects. The provision of water supply service to homes and industries has been, and will continue to be, primarily a matter of local concern. The problem requiring broader participation is essentially one of planning for the development and use of the sources of water supply. In the past, communities and industries, and even rural dwellers, were able to plan individually to meet their requirements. Today and in the future, cooperative planning is necessary to make joint use of available water sources to satisfy broad regional, metropolitan, and multi-city and multi-industry needs.

The Public Health Service is already undertaking comprehensive planning for municipal and industrial water supplies, in cooperation with the Corps of Engineers and Bureau of Reclamation, under the provisions of the 1958 Water Supply Act. Preliminary reconnaissance studies estimating municipal and industrial water requirements, including river flows needed to improve water quality for all purposes, have been made for the Rogue and Upper Snake River Basins. Similar studies are under way for the Willamette Basin and planned for the Umpqua Basin. The findings of these studies are designed for incorporation into comprehensive basin development plans of the Corps of Engineers and Bureau of Reclamation for those basins. The Columbia River Basin Project of the Public Health Service will extend this work to formulate recommendations for meeting the water supply needs of the entire Pacific Northwest region.

The growing cities and industries of the Pacific Northwest require increasing quantities of water and produce increasing quantities of wastes. Planned programs of water supply and water quality management are needed to keep pace with regional growth.

Eugene, Oregon

Tacoma, Washington

Water Quality Management

In contrast to conditions in many other parts of the Nation, water quality in the Pacific Northwest is still generally very good, with vast quantities of relatively unpolluted water available. At the same time, however, serious pollution problems do exist in various parts of the region, resulting in deterioration of the quality of water supplies, damage to sport and commercial fisheries, and in undesirable public health and aesthetic conditions. The major aims of a comprehensive program of pollution control must be to reclaim polluted water in those cases where deterioration has occurred, and to safeguard the excellent water quality now existing in much of the region, in the face of anticipated growth and development.

This growth will result in significant increases in pollution loads. The United States Senate Select Committee on National Water Resources estimated the municipal and industrial waste loadings of Pacific Northwest waters as follows (in population equivalents): 1/

	Municipal Wastes	Industrial Wastes
1950	---------	13,500,000
1954	2,200,000	----------
1980	2,800,000	60,000,000
2000	3,000,000	180,000,000

In addition to these waste loads, various land and water use practices, such as irrigation, mining, and gravel washing, cause deterioration in water quality. Widespread spraying with insecticides and other agricultural chemicals is increasing in the Pacific Northwest. Indicative of the growing importance of such contamination is the fact that the first summary of nationwide fish kill data made by the Public Health Service showed that agricultural poisons are causing the largest number of fish kills, 73 of the 185 reported.

An important corollary public health problem is the production of large numbers of disease-transmitting or nuisance mosquitoes as a result of water management practices such as reservoir operation and irrigation. Mosquito-transmitted encephalitis is a serious disease of humans and livestock in some parts of the Pacific Northwest.

The major pollutants from the wide variety of sources which influence the region's waters can be classified as follows:

1. Oxygen depleting wastes. The decomposition of organic wastes, such as domestic sewage or wastes from pulp and paper and food processing industries, can result in the reduction of dissolved oxygen. Certain water management practices, such as the release of waters from the lower levels of storage reservoirs, can also result in oxygen depletion.

2. Pathogenic organisms. Disease-causing bacteria, viruses and other organisms are discharged to waters in domestic sewage and in some industrial and agricultural wastes.

3. Nutrients. Plant nutrients, such as nitrates and phosphates, associated with domestic sewage, industrial wastes, and land drainage can result in nuisance growths of aquatic organisms.

4. Toxic substances. Toxic substances are discharged as components of municipal and industrial wastes or escape to water as result of land treatment practices. Phenols, cyanides, and insecticides such as dieldrin and DDT are examples of this wide range of toxic pollutants.

5. Sediment. Numerous activities contribute to the sediment loads of streams. Among these are improper forest and agricultural land management practices, mining operations, gravel washing and road construction.

6. Radioactivity. Radioactive substances are discharged to waters from atomic energy installations.

7. Heat. Increases in water temperature occur as a result of the discharge of industrial cooling water, and of land and water management practices, such as reservoir operation and irrigation.

8. Floating solids. Floating solids discharged in inadequately treated domestic sewage and industrial wastes cause aesthetic nuisances.

All of these categories of pollution, singly or in combination, are already degrading water quality in the Pacific Northwest to varying degrees, adversely affecting such beneficial water uses as fisheries, irrigation, water supply and recreation. A comprehensive program for the protection and improvement of the region's water quality must not only encompass the treatment of municipal and industrial wastes, but must also include the adoption of suitable land and water management practices.

Current pollution control activities of the Public Health Service in the Pacific Northwest include research and investigation of pollution problems, law enforcement activities on interstate waters, and technical and financial assistance to states and communities. These programs are coordinated with the activities of the Pacific Northwest States and Federal agencies by a number of means.

The Columbia Basin Inter-Agency Committee provides a means of achieving general coordination of activities among the seven States and seven Federal departments

1/ One population equivalent is equal to the oxygen-consuming wastes produced by one person per day.

dealing with water and related land resource development in the Columbia Basin. The Water Supply and Water Pollution Control Subcommittee of the Inter-Agency Committee is a forum for dealing with matters specifically related to water supply and water pollution control.

The Pollution Control Council, Pacific Northwest Area, representing the Public Health Service, the four Northwest States, the State of Alaska, the Canadian Department of National Health and Welfare, and the Province of British Columbia, provides a similar forum. The Council has adopted basin-wide pollution control objectives, agreed on sewage treatment works design criteria, has suggested the development of a program by the International Joint Commission to maintain the excellent quality of the international boundary waters between Washington, Idaho, Montana, and Canada, has prepared a manual of watershed management practices, and has in other ways coordinated Basin pollution control activities.

The Columbia River Advisory Group, comprising representation from the Public Health Service, Washington and Oregon, acts as advisor to the Hanford Works of the Atomic Energy Commission on problems of radioactivity involving the Columbia River. A Technical Coordinating Committee, with similar representation, has been established to carry out the Action Program established by the Conference on Pollution Problems of the Lower Columbia River below Bonneville Dam. The Conference, called under the enforcement provisions (Section 8) of the Federal Water Pollution Control Act, established time schedules for remedial action by communities and industries on the Lower Columbia.

These and other well-established means of interagency coordination will provide channels whereby the findings and recommendations of the proposed study can be fully integrated with the programs of other Federal and State resource agencies.

Adequacy of Water Resources

The water resources of the Pacific Northwest provide many opportunities for future regional growth, such as industrial development, expansion of irrigation agriculture, and enhancement of outdoor recreation. These opportunities are widespread throughout the region, and vary in relation to the distribution and characteristics of the water resource.

The maximum beneficial use of the region's water resources is dependent upon information as to the amount of water available in the various sub-basins, and as to the flow and quality characteristics. Such information is basic to the programs of the resource agencies operating in the Pacific Northwest, and a large number of State and Federal agencies are collecting data on the quantity and quality characteristics of water resources. Vast amounts of data have been collected either on a continuous basis or in connection with specific investigations.

The Public Health Service, for example, collects water quality data both on a long-range basis for its national water quality network, and on a short-term basis for specific studies. Currently, six water quality network stations provide information on the physical, chemical, biological, and radiological characteristics of waters in the Columbia Basin. These stations are located on the Columbia River at Wenatchee, Washington, Pasco, Washington, Bonneville Dam, and Beaver Army Terminal, Clatskanie, Oregon; and on the Snake River at Weiser, Idaho, and Wawawai, Washington. The network will soon be expanded by the addition of new stations on the Columbia River at Northport, Washington, and McNary Dam; on the Snake River at Ice Harbor Dam; on the Yakima River near Richland, Washington; and on the lower Willamette River at Portland, Oregon. Further expansion of the network is planned for the future.

At present the existing data are not assembled in any single report or source, which can provide a concise assessment of the volumes and quality of water available for use in various parts of the Pacific Northwest. A series of reports compiling, analyzing, and interpreting these widely scattered data into practical, usable information for each sub-basin would serve important purposes related to the Public Health Service's responsibilities in water supply and water quality management.

This sampling installation at Clatskanie, Oregon, on the lower Columbia River is part of the Public Health Service's National Water Quality Network, designed to provide continuing information on the physical, chemical, biological and radiological characteristics of water.

The carbon filter shown here, is a special device for measuring complex organic chemicals, of growing significance as pollutants.

A comprehensive report on the adequacy of water resources will readily permit comparisons of the relative availability and usability of water resources in various portions of the region. It will provide potential water users, such as industries having specific water quality and quantity needs, with the information which is required for intelligent site selection. It will aid State planning and development agencies, Chambers of Commerce, and others interested in stimulating industrial development in attracting water-using industries to the Pacific Northwest. The report will provide information which can aid agencies with responsibilities for functions such as recreation and fish and wildlife in determining the suitability of water for these uses on a region-wide basis. The report will define the present quality characteristics of the region's water resources, and serve as a base against which changing trends could be judged through a process of periodic review and updating.

Research Requirements

Various factors, such as climate, topography, and pattern of land use and industrial development, combine to give the Pacific Northwest its special regional character. These factors also result in water problems which are peculiar to the region. Research, directed toward these specific regional problems, is needed to develop the knowledge which will enable their solution. The region's research needs are accelerating as land and water use grows more intense, and as sources of pollution increase both in numbers and in variety.

Some of the industries of particular importance in the Pacific Northwest, such as pulp and paper and various food processing industries, are large contributors of wastes. The development of effective and economical means by which such industries can utilize, recover or treat their process wastes to prevent them from deteriorating the quality of public waters is an important area of research need. Much of this research can be viewed as a contribution to economic development of the Pacific Northwest, as well as a means of controlling pollution. If answers to waste disposal problems can be obtained, industrial development in the forest-based industries will have greater flexibility for location, and greater economy can be achieved in the utilization of the important forest resources of the region. By-product recovery also promises opportunities for the development of new industries, such as the wood-chemical industry.

Research on municipal sewage treatment processes is also required. The development of new methods of sewage treatment is a national, rather than specifically a regional, need. This problem does have important regional aspects, however, such as the adaptation of sewage lagoons to Pacific Northwest climatic conditions.

Other important research problems involve the land and water use practices which influence the quantity and quality of water supplies, and the effects of these quantity and quality changes upon beneficial water uses. Land-use operations in forest, agricultural, and urban lands, for example, have profound effects upon both the quantity and quality of water resources. Siltation, which is often a major consequence of improper land use practices, has serious effects upon the region's valuable fisheries resources. Toxicity from the increasing range of agricultural chemicals finding their way into streams is particularly important in this respect. Water management practices, such as the operation of reservoir systems or the recharge of ground water aquifers, exert many influences on water quality. Irrigation return flows affect water temperature and mineral and toxic pesticide content. Such factors are of growing importance as the region makes increasing reuse of its water resources, yet many of them are little understood.

The Public Health Service is already conducting three types of research programs in the Pacific Northwest. These programs are as follows:

1. The granting of research funds to universities in the region for conducting research on pertinent problems. During the past two years over $500,000 of such funds were distributed to the University of Washington, Washington State University, Oregon State College, the University of Idaho, the University of Montana, and Reed College.

2. The stimulation of research through such means as the sponsoring of symposia and regular liaison with the region's universities. During the past two years, four such symposia were attended by over two hundred technical persons representing public and private institutions throughout the region. Inventories of current research projects related to water pollution being conducted in the Pacific Northwest have been prepared.

3. The investigation and interpretation of various water characteristics in connection with the regular Public Health Service water supply and water pollution control programs in the area and in cooperation with State agencies. As an example of the latter, an oceanographic investigation, one of the first of its nature in the Nation, is now being undertaken to identify some of the problems involved in preserving the water quality of the Umpqua Estuary, where industrial development is taking place.

Recognition of the special water quality research problems of the Pacific Northwest has led to testimony before the Senate Select Committee on National Water Resources requesting the establishment of a regional water pollution research laboratory to deal with the broad range of pollution problems indigenous to the region.

SUB-BASIN STUDY AREAS

The Pacific Northwest region has been divided into sub-regions for purposes of the Columbia River Basin Project. Each of these sub-regions has individual water resource characteristics and, in general, constitutes an

hydraulic unit or units for water management purposes. The region has been divided into the following sub-regions.

Lower Columbia River Basin
Upper Columbia River Basin
Lower Snake River Basin
Upper Snake River Basin
Yakima River Basin
Umpqua River Basin
Willamette River Basin
Clark Fork-Pend Oreille River Basins
Kootenai River Basin
Spokane River Basin
Central Oregon River Basins
Oregon Coast
Washington Coast
Puget Sound

Five sub-basins, each representing a major part of the Pacific Northwest region, will be discussed below, in order to describe the region's water supply and water pollution problems in greater detail. These discussions, based upon available sources of information, illustrate the varied range of situations with which the Columbia River Basin Project will be concerned.

Main Stem, Lower Columbia River

Almost all of the 324 mile stretch of the Columbia River below the confluence with the Snake River acts as the boundary between Oregon and Washington. The course of the river in this stretch is west, passing through both the Cascade and Coast mountain ranges before reaching the sea.

Over 1,100,000 people live along the banks of the Lower Columbia. Almost 900,000 of these are residents of the Portland Metropolitan Area, at the junction of the Willamette and Columbia Rivers.

Major manufacturing activities in the region include wood processing, pulp and paper production, aluminum reduction, food processing, and miscellaneous manufacturing. Service industry employment supports a major part of this area's labor force. This is largely due to its strategic location with respect to ocean transportation and to its central location for serving the Pacific Northwest area. Agriculture is also an important part of the area's economy. The types of agriculture practiced vary considerably, depending on the local conditions. A major product is wheat grown east of the Cascades.

Three Corps of Engineers reservoirs, McNary, The Dalles, and Bonneville, are located in this stretch of river. A fourth reservoir, John Day, is now under construction. These multipurpose structures produce the large amounts of low cost hydropower which are vital to the economic development of the Pacific Northwest, and provide for flood control, navigation, and recreation. The Bureau of Reclamation has recently formulated a project to pump water from The Dalles reservoir for the irrigation of adjacent orchard lands.

The salmon and steelhead trout fisheries of the Lower Columbia are very important for both sport and commercial purposes. The Oregon Game Commission and the Washington Department of Fisheries estimated that during a seven-week period in the summer of 1959, 19,000 boat trips and 75,000 fishing trips were made by sport fishermen in the Lower Columbia. The catch consisted of 23,384 chinook, and 50,500 silver salmon. There are no figures available on the amount of money spent on this recreation, but this is estimated to exceed several million dollars an-

Expansion of research, at governmental, educational, and industrial facilities throughout the region, is required to produce the knowledge necessary to cope with the growing complexity of pollution problems. During the past two years, the Public Health Service has distributed research grants totalling over $500,000 to universities in the Pacific Northwest to support research related to water pollution.

Experimental waste water oxidation lagoon, Oregon State University.

nually. The Columbia River commercial fishery is also extremely valuable. In recent years, it has been estimated to yield a return of $20,000,000 annually. The lower river is an important pathway for fish migrating upstream to spawn.

Pleasure boating is very popular and is increasing in this area. Some 12,500 small craft are located along the Lower Columbia River. The river is also intensively used for water skiing and swimming, particularly above Portland and Vancouver.

The quantity of water now available in this reach of the Columbia River is sufficient for all present requirements and for those in the foreseeable future. Almost all the communities located on the river depend upon tributary streams and wells for their domestic water supplies. Only two small domestic water supplies are drawn directly from the main stem of the Lower Columbia River, one at Clifton, Oregon serving only twelve homes, and one at Longview, Washington, where a pulp and paper mill draws domestic water for one thousand employees. This mill and another pulp and paper mill at Vancouver, Washington are the only two major industrial users of Lower Columbia River water.

Water quality along much of the Lower Columbia River is still generally very good, with the river suitable for the various beneficial water uses, such as water supply and recreation. From the vicinity of Portland downstream, however, the river is badly polluted. Serious bacterial contamination occurs as a result of the discharge of inadequately treated sewage from the cities of Portland and Vancouver. Immediately below the Portland-Vancouver area the concentrations of coliform organisms are about one hundred times the Pacific Northwest Area Pollution Control Council's water quality objective for bathing waters and twenty-six times the objective for water used for boating, fishing, and other activities involving similar contact with the water. In the vicinity of the water intake at Longview, Washington, the estimated average concentration of coliform organisms originating in sewage discharged upstream is twice that which is recommended as a source of domestic water supply with the type of water treatment provided.

Partially treated sewage from thirty-nine communities is discharged to the Lower Columbia River, but nearly ninety-three per cent of the bacterial contamination cited above results from sewage discharged in the Portland-Vancouver area. It is estimated that nearly ninety-seven per cent of the combined contamination from the Portland-Vancouver area is from the City of Portland's sewage.

Seven pulp and paper mills discharge wastes with a combined population equivalent of some 2,850,000 to the river. Wastes from these mills, which use chemical pulping processes, are principally responsible for the growth of bacterial slimes in the lower reaches of the river. The areas where slime growths have been observed are downstream from pulp and paper mills located at Camas, Vancouver, and Longview, Washington. Another mill, located at Oregon City on the Willamette River, contributes to the problem by barging most of its sulfite waste liquor to the Columbia River below the mouth of the Willamette River, where this is discharged during the months of July through October. Another mill at St. Helens discharges a relatively small amount of wastes to the river on the Oregon side. In passing downstream these wastes supplement the wastes from the Longview area and may contribute to the growth of slime for many miles below Longview.

The slime growths, consisting chiefly of the bacteria, Sphaerotilus, are non-pathogenic, but interfere with sport and commercial fisheries from just below Camas, Washington all the way downstream to the river's mouth. The slime grows in profuse quantities and breaks loose and drifts downstream, fouling the gill nets of commercial fishermen and the lines and lures of sport fishermen. The drifting slime causes a financial loss to commercial fishermen and reduces the pleasure and effectiveness of sport fishing and other water-based recreation.

The joint Action Program of the States of Washington and Oregon and the Federal Government, established under the enforcement provisions of the Federal Water Pollution Control Act, calls for remedial measures by cities and industries to alleviate the problems described above. The reduction of slime growth and coliform concentrations would yield significant benefits to water use in the Lower Columbia River.

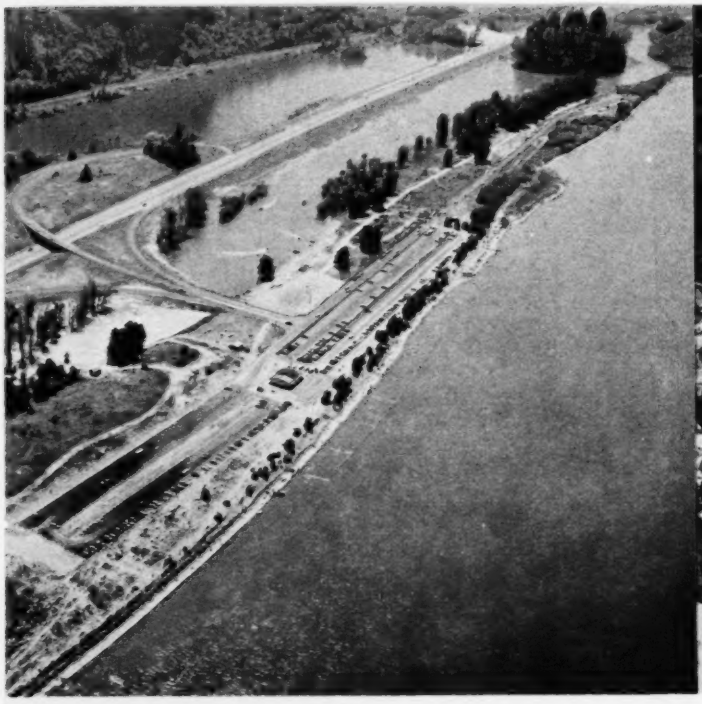
The Atomic Energy Commission Works at Hanford is located just upstream from the stretch of river being described here as the Lower Columbia. This installation discharges large volumes of low-level radioactive wastes to the river, and represents another potential pollution problem in the Lower Columbia area.

Willamette River Basin

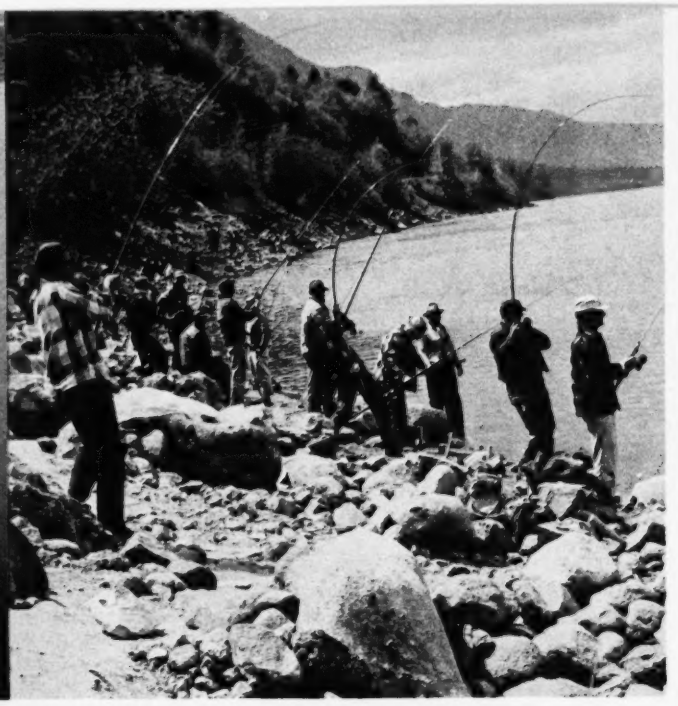
The Willamette River is a major tributary of the Columbia River, draining an area of 11,200 square miles in northwestern Oregon. The Basin extends south from the Columbia about 150 miles, and lies between the Coast and Cascade mountain ranges. Its east-west dimension averages 75 miles. Much of the Basin is composed of level or gently rolling valley floor supporting agriculture and numerous densely populated areas. The foothills and mountainsides are largely forest lands. The intersection of the Willamette River with the Columbia is the site of the Basin's largest city, Portland, Oregon.

The 1960 population of the Willamette River Basin was 1,160,000 persons. This figure represents two-thirds of the State's population. Over 60 per cent of the Basin's population lives within the Oregon portion of the Portland Metropolitan Area, adjacent to both the Willamette and Columbia Rivers.

The major primary industries of the middle and upper portions of the Basin are related to forest products and



Rooster Rock State Park, Oregon



Columbia River near Troutdale, Oregon

The lower Columbia River is intensively used for fishing, bathing, and boating. Rooster Rock State Park shown above, is one of the unique scenic and recreational attractions within twenty miles of metropolitan Portland. The bathing waters reaching this park are of exceptionally high quality. They contain an average of less than one hundred coliform organisms per hundred milliliters of water, as measured at the Public Health Service's National Water Quality Network station located at Bonneville Dam upstream.

agriculture. The principal use of valley land in this part of the Basin is for agriculture, and food processing plants are major employers during certain seasons. Industry at the lower end of the Basin, in the Portland area, is considerably more diversified, with a large amount of manufacturing. Major industrial categories in terms of employment are food and related products, lumber and wood products, primary metals, machinery, and fabricated metal products. In addition to manufacturing, the Portland area serves as the outlet of the Willamette Basin, is the major port of the Columbia River, and is a distribution and service industry center for a large portion of the Pacific Northwest.

The Corps of Engineers has five multipurpose reservoir projects now in operation in the Basin: Detroit, Dorena, Lookout Point, Cottage Grove, and Fern Ridge Reservoirs. Their primary purposes include flood control, power, navigation and irrigation. Two other such projects, Hills Creek and Cougar Reservoirs, are under construction; five others are authorized; and two more are recommended. There are also eight single purpose hydropower projects existing and under construction in the Basin.

The Bureau of Reclamation has estimated a potential irrigable acreage in the Willamette Basin of 650,000 acres. About 200,000 acres were irrigated in 1959. Projects under consideration by the Bureau of Reclamation represent future irrigation development of an additional 112,000 acres. Most of these projects would utilize storage water from flood control reservoirs. Under the ultimate plan of flood control storage in Corps of Engineers reservoirs, about 850,000 acre-feet of water would be available for irrigation purposes. The Bureau of Reclamation is also studying several projects of its own as means of developing storage for irrigation water.

The existing and proposed reservoir projects in the Willamette Basin provide for a number of important water uses. At present, however, no provisions specifically for municipal and industrial water supply or pollution control are included.

A large majority of the Basin's population and nearly all of the large industrial water users depend upon surface water supplies. At the present time almost all municipal water systems in the basin depend for their water supply upon tributary streams rather than the main stem of the Willamette River. Of the ninety community water supplies in the Willamette Basin, fifty-two now utilize surface water and of these, only three obtain water directly from the main stem of the Willamette River. However, with several communities, including Salem and Albany, now approaching the ultimate capacity of their present water supplies, future water requirements will undoubtedly have to come from the main stem of the Willamette River or directly from one of the multipurpose storage projects located in the Basin.

Water shortages have become so critical in some tributary basins that pumping from one drainage basin to another is being seriously considered. Several communities in one water service area are now studying the feasibility of pumping water from the Wilson and Trask River Basins across the Coast Range into the upper Tualatin River Basin. Four of the Basin's seven pulp mills now use the Willamette River as their source of water. These seven mills require some 60,000,000 gallons of water per day.

The quantity of water available in the Basin on an annual basis for all purposes is considered to be adequate for any foreseeable economic development if sufficient storage can be provided to augment the natural flows during several summer months. The long-term average discharge of the Willamette River at Salem is 23,500 cubic feet per second. The average low flow under present conditions of regulation is 5,500 cubic feet per second. This flow is maintained by the Corps of Engineers from upstream storage in order to provide for navigation, but it provides important benefits through improvement of water quality, as well.

The lower reaches of the Willamette River are grossly polluted. Seven pulp and paper mills discharge wastes to the river with an estimated population equivalent of 2,500,000. The pulp and paper mill wastes represent approximately 87 per cent of the total population equivalent now being discharged into the Willamette Basin.

Although all cities on the main Willamette River have sewage treatment works, most of these provide only primary treatment and disinfection. The Oregon State Sanitary Authority is engaged in a strong pollution abatement program on the Willamette River, directed towards requiring present contributors of pollution to adequately treat their effluents. The Authority has determined that secondary treatment and disinfection should be provided for all sewage effluents discharged into the Willamette Basin. However, in the past several years sources of pollution in the Willamette River Basin have increased almost as rapidly as treatment facilities.

Logging operations and road construction done without proper regard to protecting soil and water resources contribute to the turbidity and siltation of the basin's streams and present another serious water quality problem.

Pollution conditions seriously affect beneficial water uses throughout much of the lower Willamette River. The dissolved oxygen content during the summer months is critical in relation to the passage of anadromous fish, and the high bacterial content renders the river unsatisfactory for recreational use. The lowest monthly average of dissolved oxygen values recorded in the Portland Harbor in 1959 was 2.9 parts per million for August. Although this represented a slight improvement over previous years from the standpoint of dissolved oxygen, the bacteriological pollution during 1959 was practically the same as in 1957 and 1958.

Much of the potential future economic development in the Basin will be dependent upon the full utilization of its water resources to meet the water demands of municipalities and industries. This cannot be accomplished until the Basin's waters are restored in quality sufficiently to permit their use for all beneficial purposes, and adequate quantities are assured to meet anticipated needs. Additional storage for these purposes will be required. Seasonal low flows must be augmented to provide for reuse of the Basin's waters by cities and industries without serious deterioration in quality.

In addition to meeting the water requirements of municipalities and industries, the achievement of full utilization of the Basin's water supplies requires that water quality be adequate for other beneficial and legitimate water uses including irrigation, fish and wildlife, recreational use, and navigation. Although some of these uses represent undeveloped potentials, several are presently under-utilized mainly because of poor water quality. For example, water-oriented recreation is unsafe for health reasons along much of the Willamette, but the extensive use of upstream storage reservoirs indicates a desire for this type of recreation. Although the newly completed Detroit Reservoir is at some distance from the populated areas adjacent to the main stem of the Willamette, 313,500 visitors were recorded as utilizing the reservoir for recreation in 1959.

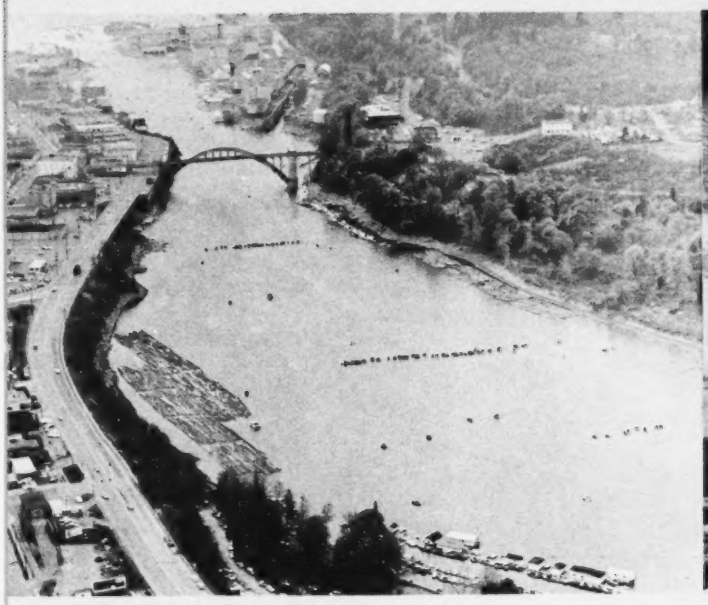
As a related development, a conflict has occurred between recreational use of water in reservoirs and downstream water uses including recreation. The recreational attractions of several of the storage reservoirs have been so great that considerable pressure has been exerted by recreational interests to prevent the drawdown of the reservoirs even when this was needed to fulfill their primary purposes.

Upper Snake River Basin

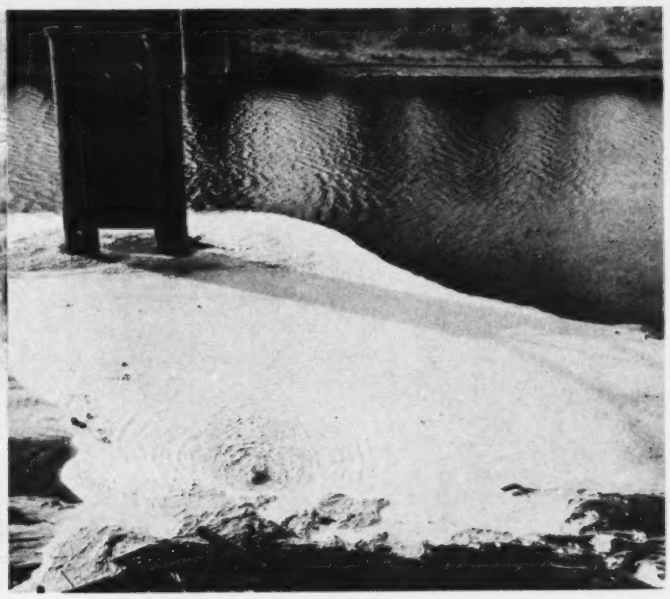
The Snake River is the largest tributary of the Columbia River in terms of length and drainage area. The Upper Snake includes a stretch of river about 735 miles in length. From its source in Yellowstone National Park, this stretch of river flows southwest for more than 500 miles to King Hill, Idaho, and then in a northwesterly direction for some 235 miles to the Powder River. The Upper Snake Drainage comprises 28 per cent of the Columbia Basin and includes western Wyoming, all of southern Idaho except the extreme southwest corner, the northwest corner of Utah, the northeast corner of Nevada, and a part of eastern Oregon. The great Snake River Plain of the Upper Snake River Basin comprises a level area of 73,000 square miles, surrounded by high mountains. The long-term average discharge of the Snake River at King Hill is 10,530 cubic feet per second.

The 1960 population of the Upper Snake Basin was approximately 532,000. The economy of the Basin is based upon its natural resources. Agriculture and the processing

Sewage and industrial wastes create a hazard to the salmon fishery of the Willamette River.



Sport fishermen at Oregon City, Oregon



Pulp mill wastes at Newberg, Oregon

of agricultural products, primarily sugar beets, potatoes and vegetables, livestock, feed crops and dairy products are of prime importance. Lumbering and mining are other resource based industries practiced in parts of the Basin, but these comprise a relatively small portion of the total economy. Phosphate mining and refining are important in the vicinity of Pocatello, Idaho. Significant growth in resource based industries, particularly food processing, is expected to occur in the future.

Municipal and industrial water needs are supplied chiefly from ground water sources. In general, these sources are adequate in both quantity and quality to meet present demands. There are, however, areas where problems are arising in maintaining and developing sources of water.

The City of Twin Falls, Idaho, presently uses 10,500,000 gallons of water per day to supply domestic and industrial users. The present source of supply consists of ground water and of surface water drawn from the Snake River. The City's anticipated water use by the year 2010 will be 45,000,000 gallons per day. Ground water is limited in this area, and future water needs will be met from the Snake River, which is presently of poor quality as a result of pollution. Other cities which have indicated that surface water supplies will be required in the future are Weiser and Pocatello. Pocatello has already taken steps to secure stored water from the Bureau of Reclamation's Palisades Reservoir.

Although the aquifer underlying a major portion of the Basin has an extremely high yield, increasing irrigation depletions from underground sources will certainly create localized water shortages in the future. Primarily, water resource planning in the Basin has been directed toward agricultural use. Planning for future municipal and industrial water supplies must be done to provide for water demands associated with the Basin's anticipated development. A reconnaissance study has been made by the Public Health Service as a first step in delineating water supply and pollution control needs in relation to proposed Corps of Engineers and Bureau of Reclamation water development projects in the Upper Snake Basin.

At present, 59 cities and 156 industries discharge waste to water courses in the Basin. Only 18 per cent of these sources of waste discharge are considered to have adequate treatment. Although the number of adequate municipal and industrial waste treatment facilities has increased substantially during the past decade, the number of pollution sources has also increased, resulting in an increase in the total population equivalent of wastes from 1,700,000 in 1950 to more than 2,300,000 in 1960. Construction of waste treatment facilities has not kept pace with this need.

The known population equivalent discharged from industrial sources at the present time is about 2,400,000, of which 2,000,000 is contributed by 24 industries. Thus, 15 per cent of the industries contribute 87 per cent of the

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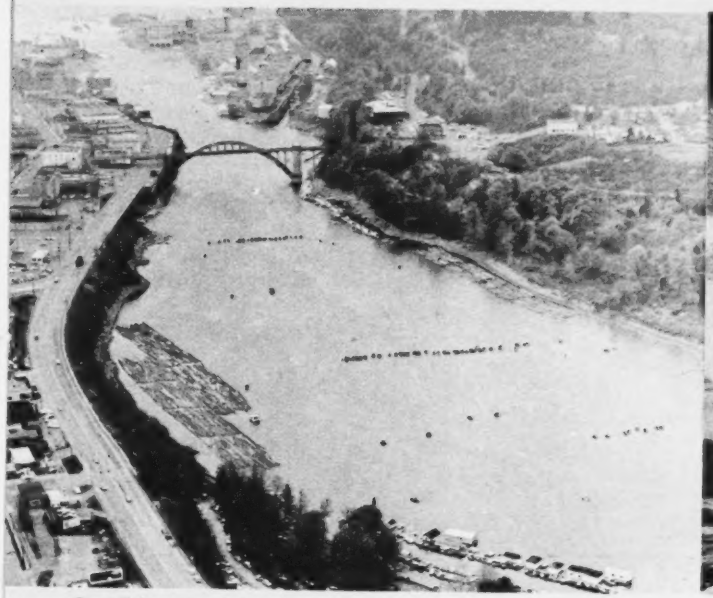

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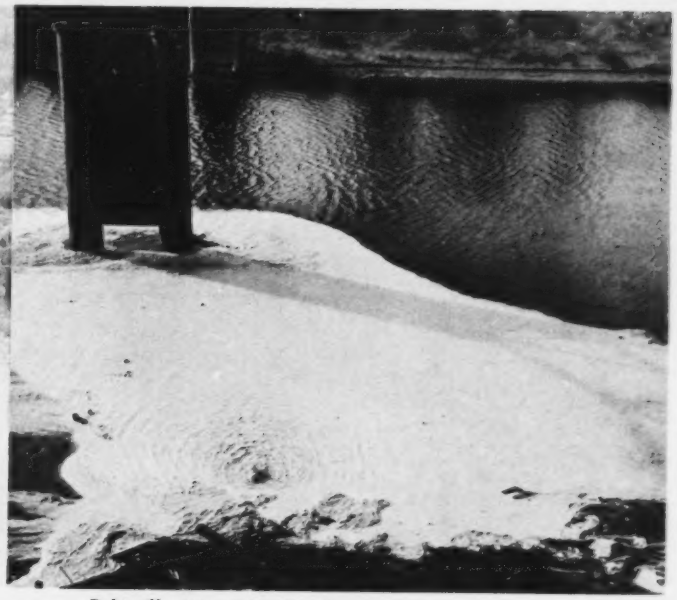

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At present, 59 cities and 156 industries discharge waste to water courses in the Basin. Only 18 per cent of these sources of waste discharge are considered to have adequate treatment. Although the number of adequate municipal and industrial waste treatment facilities has increased substantially during the past decade, the number of pollution sources has also increased, resulting in an increase in the total population equivalent of wastes from 1,700,000 in 1950 to more than 2,300,000 in 1960. Construction of waste treatment facilities has not kept pace with this need.

The known population equivalent discharged from industrial sources at the present time is about 2,400,000, of which 2,000,000 is contributed by 24 industries. Thus, 15 per cent of the industries contribute 87 per cent of the

total waste load. The beet sugar industry operating over a 160 day season produces a daily population equivalent of 1,600,000, and the potato industry has a population equivalent of 1,000,000 in season. Fortunately, most of these industries apply some treatment by dilution, screening, chemical precipitation and by-product recovery, effecting some reduction in the total waste discharged. Two sugar beet processors at Paul and Twin Falls discharge population equivalents of 284,000 and 486,000 respectively to tributaries of the Snake River, even after primary treatment. Five potato processors in the Idaho Falls area discharge a combined population equivalent of 438,000 to the Snake River.

At present, pollution problems exist in the Boise River, Indian Creek, Minidoka Main Drain, Rock Creek, and the Snake River. Future problems are anticipated in areas where industrial and population increases are forecast. Study of the characteristics of present and anticipated waste discharges and of the assimilative capacity of the receiving streams is required to estimate the requirements for storage and flow regulation necessary to complement adequate waste treatment facilities in restoring and maintaining water quality.

Irrigation and the use of agricultural chemicals are significant sources of pollution within the Basin. Irrigation return flows have already had a major detrimental effect on the quality of both surface and ground waters. This in turn has affected various beneficial water uses, such as rural, municipal, and industrial water supplies, fisheries and recreation. The magnitude of these problems in the Basin is not well defined. However, sufficient information is available to establish that problems of major proportions exist.

For example, available data show increases in total concentration of salts in the Boise River, ranging from 500

Continued re-use of irrigation waters creates water quality problems in the Snake River Basin.

to 2000 per cent as a result of irrigation. Increases in hardness of streams of from 400 to 700 per cent are not uncommon. Increases in temperature, turbidity, color, and bacterial content also occur as a result of irrigation, as do concentrations of plant nutrients, especially nitrogen and phosphorus. The latter substances have resulted in heavy aquatic growths in ditches, canals, and streams.

Unusually high rates of enteric diseases have occurred in the past several years during the late summer and fall months in the highly developed irrigated valleys of the Upper Basin. Idaho State Department of Health officials have stated that a contributing factor to these outbreaks is the discharge of raw and partially treated sewage into streams from which water is subsequently diverted for irrigation. This contaminated water is spread over thousands of acres of land with subsequent seepage into shallow ground water supplies serving rural areas. In addition, the only available drinking water supply in many areas is water taken directly from irrigation ditches or from cisterns filled with water from canals.

Recently the ground water pollution problem was brought to the attention of the United States Senate Select Committee on National Water Resources by the Idaho State Department of Health. It was noted that water quality is generally good in the vast ground water reservoir underlying the Snake River Plain and serving as a source of water for many cities, but that, because of the inadequate filtering action of the aquifer, contamination is occurring in certain areas. Future use of the underground basin as a source of water supply will be dependent upon solution of these pollution problems.

At present, many localities in the Snake River Basin are experiencing serious problems with encephalitis-transmitting and nuisance mosquitoes. Studies have shown that the major mosquito sources in most of these localities result primarily from poor water management and inadequate drainage associated with irrigation, and secondarily from the flooding of bottom lands and other low areas by overflow of streams and rains of high intensity. It is expected that the expansion of irrigation in the Basin will be accompanied by an increase in the overall mosquito problem, particularly if mosquito preventive measures are not incorporated into the design, construction, operation and maintenance of irrigation projects.

Yakima River Basin

The Yakima River is a major tributary of the Columbia River, joining it in the vicinity of Pasco-Kennewick, Washington. The Yakima River Basin contains about 5,000 square miles and drains a major portion of the east slope of the Cascade Mountains of Washington.

The river has a long-term average flow of 3,840 cubic feet per second.

The 1960 population of the Basin was about 185,000 persons. The largest communities within the Basin are Yakima (43,019 persons) and Ellensburg (8,575 persons).

Agriculture is the largest source of primary employment in the Basin. The majority of this is based on irrigation, but there is a considerable amount of grain production on the eastern portion of the Basin. The largest coal mine in the State is located near Roslyn in the northern part of the Basin. The western and northern portions of the Basin support a moderate amount of employment in the forest products industry and have extensive recreation potentials. Recreational use of reservoirs is increasing and may eventually reach major proportions. Many summer homes are located on National Forest lands in the Basin.

The United States Fish and Wildlife Service has reported the Yakima River Basin to have a commercial fishing value approaching $100,000 per year and a sports fishery whose economic value exceeds $300,000 annually. This stream was at one time a major producer of chinook and silver salmon, and steelhead trout. It still is an important salmon-producing tributary of the Columbia River, but the runs have been reduced to a very small percentage of their former magnitude. Construction of dams, depletion of streamflows as a result of irrigation, increased water temperatures, and pollution by sewage and industrial wastes have contributed to the decline in fish production.

Water supply in the Yakima Basin is at times inadequate due to the demands of irrigation and the lack of sufficient storage. Most of the smaller communities in the valley obtain supplies from wells. The ground water supplies in certain areas, however, are unsatisfactory, and communities under such conditions are forced to use surface water from the river, tributaries or irrigation canals. The cities of Yakima, Ellensburg, Cle Elum, Roslyn, and Easton obtain much of their supplies from surface sources. Large portions of the population in the Tieton and Rosa irrigation projects fill domestic water cisterns from irrigation canals.

There is also an increasing need for water for industrial purposes. Most of the Basin's industries depend on the municipalities for water. Some, however, operate their own wells.

The City of Yakima is the largest municipal water user, drawing its water from three ground water sources and four surface sources. The surface sources are all regulated by means of storage reservoirs. The Bureau of Reclamation's reservoirs are operated in accordance with the needs of agricultural water users, and the operating schedule does not fit the needs of the city. The adequacy of Yakima's water supply is in question, indicating the need for more storage capacity specifically for municipal water supply.

Serious water pollution problems occur in the Yakima Basin. All of the communities in the Basin have sewage

treatment facilities, and most of the industries not connected to municipal sewer systems have some type of waste treatment. The total investment in municipal sewage treatment plants in the valley was reported to be about $3,500,000 in 1958. No estimate has been made of the industrial investment in waste treatment. In spite of the treatment provided, however, conditions in the river and canals, especially downstream from Yakima, often reach serious proportions. This is due in part to the lack of adequate minimum flows in stretches of the river below major irrigation diversions.

Bacterial concentrations in the streams and irrigation canals are far in excess of those considered safe and desirable. There is evidence that water temperatures have increased in the Yakima River, and that this increase has several significant effects. Increased water temperatures are detrimental to fish in that they tend to increase the incidence of disease; water is less desirable for domestic and industrial uses, especially for cooling purposes; and the rate of biological activity is increased, resulting in lower dissolved oxygen concentrations. The effects of water storage and of irrigation return flows in raising the temperature of the Yakima River have not been completely determined.

Oxygen in the river below Yakima has reached critical levels on occasion. This condition usually occurs at night when oxygen production by algae has ceased. Irrigation return flows are known to have adverse effects on the mineral content of the Yakima River. The concentration of total solids in the river at its mouth is over four times that immediately below Yakima. This is the stretch of the river where the bulk of the return flows enter the streams. Much of this increase is made up of sulfates and chlorides of calcium and magnesium. Studies have also indicated that the application of fertilizers has increased the nutrients which promote the growth of aquatic plants. The increasing use of insecticides and toxic materials has resulted in significant concentrations in the streams, the effect of which remains to be evaluated.

Umpqua River Basin

The Umpqua River Basin coincides almost exactly with the boundaries of Douglas County in southwestern Oregon. The river enters the Pacific Ocean at Winchester Bay on the central Oregon coast. The Basin contains about 5,000 square miles, most of which is between the summit ridges of the Coast and Cascade Mountain Ranges. The topography consists of heavily forested mountains separated by narrow fertile agricultural valleys. About one half of the land area is owned by the Federal Government.

The 1960 population of Douglas County was 67,703 persons. The largest community is the county seat of Roseburg, with a population of 11,283 persons.

The main primary industry of the Basin is logging and the manufacturing of forest products. Agriculture is relatively minor, with the majority of farmers having other income exceeding the value of farm products sold. However, irrigation is increasing rapidly in the Basin, with 1735 acres irrigated in 1944, 3798 acres in 1949, and 11,939 acres in 1959. About 20,000 to 25,000 acres are considered to be potentially and economically irrigable. A major producer of ferronickel is located in the southern part of the Basin. This operation involves both the mining and electrochemical reduction of local ores. About half the Basin's employment is from service industries which support the primary industries and tourism.

The Umpqua River and adjoining ocean beaches represent important and well-used recreation assets. Other important recreation areas of the Basin are found in the mountain areas, particularly those adjoining Crater Lake National Park. The Umpqua River is nationally famous for sport fishing for salmon and steelhead, cutthroat, and rainbow trout. The value of this sport fishery is considerable. At Winchester Bay alone an investment of more than $300,000 of County and private capital has been made to facilitate sport fishing.

Water problems are not extremely serious at present, but the Basin has great potential for economic development. A pulp mill will be established in the immediate future to utilize the Basin's valuable timber resources. This and similar developments indicate that prompt action must be taken if the Basin's excellent water resources are to be safeguarded.

Although there are seasonal low flow problems in some portions of the Basin, the annual water supply is abundant. The long-term average flow of the Umpqua River at Elkton is 7,070 cubic feet per second.

The principal water system in the Basin is that of the Oregon Water Corporation which supplies domestic and

The growing use of agricultural chemicals represents a threat to water quality.

Sediment, resulting from erosion such as this, has adverse effects upon fisheries and water supplies in the Umpqua River Basin.

industrial water to about 15,000 people in the Roseburg and Winchester areas. This water company obtains water from the North Umpqua River and provides treatment in the form of coagulation, sedimentation, filtration and chlorination. Presently, both the flow and the quality of the water available are satisfactory. However, highly turbid waters during the winter months create water treatment problems. The smaller communities in the basin generally obtain water from small surface streams which are also highly turbid.

Activities on the land are a significant source of water pollution. Logging, farming, and mining practices cause highly turbid waters which interfere with water treatment at Roseburg and reduce fish propagation by siltation of spawning areas. The valuable fishery of the Umpqua River is also endangered by low streamflows. In response to these problems the Oregon State Game Commission has developed a special project for rebuilding the Umpqua River salmon and steelhead runs.

Irrigation return flows are not presently a major problem, but increased irrigation, especially in the South Umpqua area, will have an effect by increasing the salt content, turbidity, and temperature of the stream.

Municipal sewage and industrial wastes do not cause serious pollution problems at present, with chemical and biological water quality apparently being very good. The six major communities have provided sewage treatment facilities and, except during periods of very low streamflows in Cow Creek and the South Umpqua River, satisfactory water quality is maintained. Increased streamflows will be needed during the summer months to adequately

assimilate the treated sewage as the area develops. The one, or possibly more, pulp mills planned for the Basin are potential sources of pollution problems. From past experience in Oregon, good site selection and a very high degree of treatment will be required if serious oxygen depletion problems are to be averted.

The Public Health Service is presently conducting a special study of the characteristics of the estuary at the mouth of the Umpqua River. Data on characteristics such as dilution and flushing patterns are being collected by means of field surveys and by use of an experimental hydraulic model of the estuary. This study should provide valuable information concerning the location and design of waste disposal facilities from potential municipal and industrial developments. The techniques of investigation being developed in this study are expected to find broad application in future investigations of other Northwest estuaries and elsewhere.

ORGANIZATION OF THE STUDY

The Columbia River Basin Project will result in a series of reports which, in combination, will provide the basis for a broadly conceived comprehensive water supply and water quality management plan for the Pacific Northwest.

The task of developing these reports will require the collection, organization, and analysis of a wide range of engineering, economic, and other data in formulating recommendations for each of the four major elements. These four elements will, of necessity, be closely interrelated throughout the course of the study and in the final recommendations. In many cases the same factual data will be employed for several purposes, and the same recommendation will apply to more than one element. The study will coordinate the various elements to provide a tightly integrated whole.

Essentially, the Columbia River Basin Project study has been organized as follows: the first three elements, water supply, water quality management, and adequacy of water resources, will be studied for each sub-basin. Concurrent studies will develop the basic information concerning the sub-basin's economy and water resources upon which these functional elements will depend. The priority in which the various sub-basins are studied will be established by the Public Health Service and the State and Federal agencies involved.

The fourth major element, research requirements, will be developed for the region as a whole, with reports prepared on a continuing basis as research needs become apparent.

The following discussions set forth the general contents of each of the major aspects of the study.

ECONOMIC BASE ANALYSIS AND FORECAST

The scope and nature of water supply and water quality management programs required to meet the needs of the Pacific Northwest region will depend upon the present and, even more importantly, upon the future characteristics of the region's economy.

This information will be developed for each sub-basin. The economic analysis will begin with an examination of the present land use and economic base, and the relationships between primary industries, service industries, and population in the sub-basin and its sub-areas. The relationship of the Pacific Northwest economy to the national economy will be considered. A forecast of future developments will then be made. This will involve examination of the various components of the economy in detail for growth possibilities. The forecast will estimate levels of population, industry, agriculture, commerce, recreation, and other water-using and pollution contributing aspects of the economy for the years 1980 and 2010.

WATER RESOURCE INVENTORY

A detailed understanding of the characteristics of the region's water resources is fundamental to the development of a comprehensive water supply and water pollution control program.

An inventory will be made of the total quantity of surface and ground water available within each sub-basin. This study will include an analysis of storage facilities, existing, proposed, or potential, and their ability to regulate the natural flow regime to provide for water needs.

In addition to this study of the sub-basin's hydrologic characteristics, an inventory of existing water rights and an assessment of the remaining unappropriated water resource still legally available for use will be included.

A vast reservoir of basic information is available from the Federal and State agencies engaged in water resources planning for application to the particular aspects of water resource development with which this study is concerned.

WATER SUPPLY

For the section of the study dealing with water supply, a detailed inventory of all municipal and industrial water users within the sub-basin will be prepared. This inventory will include for each user such data as the present water source, the quantity and quality of water used, the type of water treatment, water use trends, and sources of water planned to satisfy future needs. Future municipal and industrial water supply requirements will be computed by translating the economic potentials determined in the economic base study into water demand, recognizing changing trends in municipal and industrial water use.

The potentialities of storing water, where necessary, in order to meet these requirements will be determined. Such storage can be provided in existing reservoirs by means of modifications in the design or operation or by the addition of new projects. New projects may include multipurpose reservoirs which can be provided for in the development plans of the Federal construction agencies, or by projects currently outside the programs of these agencies.

The economic feasibility of projects will be evaluated by determining benefits of water supply storage and comparing them to the cost of providing such storage. The benefits from municipal and industrial water supply storage result from improvement in conditions of water use, largely in regard to quantity and dependability, quality, and physical convenience. Generally, the value of water supply benefits will be measured as the cost of obtaining equivalent supplies by the cheapest alternative means that would most likely be developed by the potential water users in the absence of the Federal project. When it is not possible to definitely establish the potential water users, or the alternative water supply project that might be expected to develop in the absence of the Federal project, benefits can be based on the average unit cost of comparable water supplies existing or planned in the same general region. In practice, the evaluation of water supply benefits will often be closely related to the evaluation of water quality management benefits, to be described below.

This section of the study will result in recommendations which will comprise the basis for a water supply plan. The findings will provide a broad picture of the sub-basin's municipal and industrial water supply demands and potentials. The plan will delineate municipal and industrial water supply requirements as an integral aspect of Federal multipurpose basin development programs.

WATER QUALITY MANAGEMENT

An inventory of existing pollution will be prepared. This will include the waste loadings and waste disposal practices for each municipality and major industry, and the polluting effects of land and water practices, such as logging, irrigation, and recreation. Deteriorations in water quality as a consequence of this pollution and their effect upon beneficial water uses will be determined.

On the basis of the economic forecasts of the sub-basin's growth, and giving recognition to the various trends in waste disposal and land and water use practices, the nature and volume of future pollution will be estimated. An assessment of future flow depletions as a result of increased consumptive uses will be made.

The various beneficial uses, both present and potential, of the region's waters will be delineated. The water quality management program will be designed to make optimum provision for these anticipated uses.

The various tools available in water quality control will be considered in formulating the water quality management program. These include waste treatment and control practices, site location for new industrial development, land use practices, and water management practices. A water quality management plan including the combinations of practices, or alternate practices where appropriate, necessary to provide maximum safeguards to relatively unpolluted waters and to reclaim polluted waters will be prepared.

These practices include, as one major aspect, control of pollution at the source. Utilization of available waste treatment and by-product recovery technology to achieve maximum feasible reduction of polluting loads will be recommended in all cases as a first step. Those sites which are unsuitable for future industrial locations in terms of capacity of the water to receive these wastes will be delineated. This will be guided by the findings of the economic base study, which will indicate generally the potential for industries of various types. Recommendations will be made for the adoption of land use practices which will minimize sedimentation and related pollution.

The second major aspect to be considered will be the management of the receiving waters. The ability of streams to receive pollution will be evaluated under present and anticipated future conditions, considering such factors as waste loading, sludge deposition, flow regulation, and water temperature. The volumes of streamflow which, in conjunction with full waste treatment, are necessary to maintain the desired water quality will be computed.

The potentialities of providing water storage to meet these flow requirements will be determined. As in the case

with water supply needs, this storage can be provided in new or existing reservoirs, and, in fact, the same storage space will often serve both water supply and water quality management needs.

As a related measure, recommendations for the control of disease-transmitting and nuisance insects associated with water resource development projects will be made.

The benefits resulting from storage for water quality management include gains in the value of streams for industrial, municipal, and agricultural water supply, for fish and wildlife, for recreation, for safeguarding public health, and for other purposes related to the general welfare. Economic evaluation of storage for water quality management will be developed with respect to the benefits to be derived from improvement of water quality to the extent that economic methodology provides useful tools for this purpose. Monetary benefits, such as reduction in the cost of treatment of municipal and industrial water supplies, will be calculated, where appropriate. Much of the appraisal of the benefits of water quality management aspects of projects, however, must involve non-monetary benefits which will accrue through such effects as safeguarding life and public health, stabilizing national and regional food and raw materials production, enhancing aesthetic and recreation values, and contributing to the improvement of technically underdeveloped areas. The relative significance of these benefits will be stated in as precise and quantitative terms as possible in the evaluation of projects.

This section of the study will result in recommendations which will comprise a water quality management plan. The plan will include requirements for controlling municipal and industrial pollution and for the adoption of suitable land-treatment practices, and will establish the water quality management provisions that should be included in Federal multipurpose basin development programs.

ADEQUACY OF WATER RESOURCES

The compilation of a report on the adequacy of water resources for various uses with particular reference to quality will largely utilize data already collected in connection with other aspects of this study. The preparation of the report will include an analysis of the volumes of flow available at selected locations throughout the subbasin. Water quality at these locations will be presented and interpreted in terms of various quality parameters, such as dissolved oxygen, temperature, coliform organisms, alkalinity, and chlorides. It will also be interpreted with respect to recognized criteria in terms of its suitability from the standpoint of various water uses, such as municipal and industrial water supply, aquatic life, and recreation.

RESEARCH REQUIREMENTS

Regional research requirements will be identified on the basis of findings developed throughout the course of the study. These will include appraisal of the knowledge required to cope with existing situations, and that necessary to meet emerging or anticipated problems. The various potential means for accomplishing the necessary research will be set forth, together with recommendations as to the implementation of research programs.

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THE COLUMBIA RIVER BASIN

This map shows major dam and reservoir developments in the Columbia Basin. The Columbia River Basin Project will develop the water supply and water quality management functions in relation to these major water resource development programs. (The map does not include details of adjacent coastal areas with which the project is also concerned.)

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